

## **BEAM: Technology for Autonomous Vehicle Health Monitoring**

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### **Abstract**

This paper describes in brief the architecture, application, and operating theory of Beacon-based Exception Analysis for Multimissions (BEAM) and its application to the Space Shuttle Main Engine (SSME). BEAM is an end-to-end method of data analysis intended for automated real-time fault detection and characterization. It provides a generic system analysis capability for potential application to propulsion systems, deep space probes, and other highly automated systems. It provides a generalized formalism for diagnostics and prognostics in virtually any instrumented system.

Some of the major components include the deterministic filter that incorporates physics-based models, the coherence-based fault detector that examines the correlation of multi-input signals, the dynamical invariant anomaly detector that examines the characteristic features of individual signals, and the symbolic data model component that verifies the discrete measurements using a knowledge-based rule expert system. With these flexible components and architecture, BEAM can operate on all standard forms of data, both time-varying (sensor or extracted feature) quantities and discrete measurements, embedded physical and symbolic models, and communication with other autonomy-enabling components such as planners and schedulers.

BEAM can be adapted to on-board or ground-based implementations. The approach will be illustrated with an overview of ground-based application to SSME test data, including past validations, and ongoing efforts. The dynamical invariant anomaly detector results will be presented as well as future plans for incorporating other BEAM diagnostic components for SSME monitoring.